

## WHAT IS CLAIMED IS:

- 1 1. A fuel injection valve, comprising:
  - 2 1) a valve seat member including;
    - 3 a) a valve seat face for allowing a valve body to be seated thereon when the
    - 4 valve body is closed, and
    - 5 b) an injection port formed on a downstream side of the valve seat face;
    - 6 and
  - 7 2) a nozzle plate connected to the valve seat member and disposed on a
  - 8 downstream side of the injection port, the nozzle plate being formed with a plurality of
  - 9 nozzle holes, the nozzle holes being defined radially outwardly with respect to the
  - 10 injection port, a fuel passage having a cross section substantially perpendicular to an axis
  - 11 of the injection port, the cross section of the fuel passage having a diameter which is
  - 12 substantially gradually increased, the fuel passage being defined in such a manner as to
  - 13 connect the injection port of the valve seat member to the nozzle holes of the nozzle plate.
- 1 2. The fuel injection valve as claimed in claim 1, wherein
  - 2 the fuel passage is so formed in the valve seat member as to be shaped substantially
  - 3 into a cone having a diameter which is substantially gradually and continuously increased
  - 4 toward an outlet of the injection port.
- 1 3. The fuel injection valve as claimed in claim 2, wherein
  - 2 the fuel passage is so formed in the valve seat member as to be shaped substantially
  - 3 into a frustum of the cone.
- 1 4. The fuel injection valve as claimed in claim 1, wherein
  - 2 the fuel passage is formed by tapering, such that a section is so formed as to have a
  - 3 diameter which is substantially gradually increased from substantially a center section of
  - 4 the nozzle plate to the nozzle holes which are defined radially outwardly with respect to
  - 5 the center section, the center section of the nozzle plate being opposed to the injection
  - 6 port.

1 5. The fuel injection valve as claimed in claim 1, wherein

2 the fuel passage is formed by curving, such that a section is so formed as to have a  
3 diameter which is substantially gradually increased from substantially a center section of  
4 the nozzle plate to the nozzle holes which are defined radially outwardly with respect to  
5 the center section, the center section of the nozzle plate being opposed to the injection  
6 port.

1 6. The fuel injection valve as claimed in claim 3, wherein

2 a fuel outflowing from the injection port is conveyed to the frustum of the cone of  
3 the fuel passage, converting a direction of a fuel flow from axially downwardly to radially  
4 outwardly,

5 the cross section of the fuel passage from the outlet to the nozzle holes is expressed  
6 as a cross section of a cylinder which is defined substantially around a center axis of the  
7 injection port,

8 a following expression 1 is obtained:

9 expression 1:  $S_i = 2\pi \cdot R_i \cdot H_i$

10 where

11  $S_i$  is an inlet cross section,

12  $R_i$  is a radius of injection port, and

13  $H_i$  is a height from the upper face of the nozzle plate,

14 a following expression 2 is obtained:

15 expression 2:  $S_o = 2\pi \cdot R_o \cdot H_o$

16 where

17  $S_o$  is an outlet cross section on the nozzle holes,

18  $R_o$  is a radius in this position, and

19  $H_o$  is a height from the upper face of nozzle plate,

20 forming a ceiling shaped substantially into a taper from an inlet to the outlet makes  
21 the radius  $R_o$  greater than the radius  $R_i$  and the height  $H_o$  smaller than the height  $H_i$ , and  
22 allows a height  $H$  smaller in accordance with an increase in the radius  $R$  from the inlet to  
23 the outlet, thereby controlling an increase in the cross section of the fuel passage covering  
24 the above region,

25        setting up an angle of a taper such that the outlet cross section  $S_o$  = the inlet cross  
26 section  $S_i$  and thereby  $H_i/H_o = R_o/R_i$  makes the cross section of the fuel passage  
27 substantially constant from the inlet to the outlet, while setting up a greater angle of the  
28 taper such that the inlet cross section  $S_i >$  the outlet cross section  $S_o$  and thereby  $H_i/H_o >$   
29  $R_o/R_i$  decreases the cross section of the fuel passage at a constant rate from the inlet to the  
30 outlet, and

31        setting a total cross section  $S_n$  which is cross sections of the plurality of the nozzle  
32 holes smaller than or equal to the outlet cross section  $S_o$  substantially monotonously  
33 decreases the cross section of the fuel passage from the inlet to the nozzle holes.

1        7.    The fuel injection valve as claimed in claim 4, wherein  
2        from an inlet to the nozzle holes of the fuel injection valve, the cross section of the  
3 fuel passage is formed substantially constant or substantially gradually decreased, with  
4 this, a fuel speed in the fuel passage is made constant or increased, thereby accelerating at  
5 least one of an atomization and a vaporization of a fuel, and  
6        from the injection port of the valve seat member to the nozzle holes by way of the  
7 fuel passage of the fuel injection valve, the cross section of the fuel passage is decreased  
8 substantially monotonously, with this, the fuel speed of the fuel injected from the nozzle  
9 holes by way of the fuel passage is made constant or increased, thereby further  
10 accelerating the at least one of the atomization and the vaporization of the fuel.

1        8.    The fuel injection valve as claimed in claim 5, wherein  
2        from an inlet to the nozzle holes of the fuel injection valve, the cross section of the  
3 fuel passage is formed substantially constant or substantially gradually decreased, with  
4 this, a fuel speed in the fuel passage is made constant or increased, thereby accelerating at  
5 least one of an atomization and a vaporization of a fuel, and  
6        from the injection port of the valve seat member to the nozzle holes by way of the  
7 fuel passage of the fuel injection valve, the cross section of the fuel passage is decreased  
8 substantially monotonously, with this, the fuel speed of the fuel injected from the nozzle  
9 holes by way of the fuel passage is made constant or increased, thereby further  
10 accelerating the at least one of the atomization and the vaporization of the fuel.